

Current Status of Biological Control of Squarrose Knapweed in California

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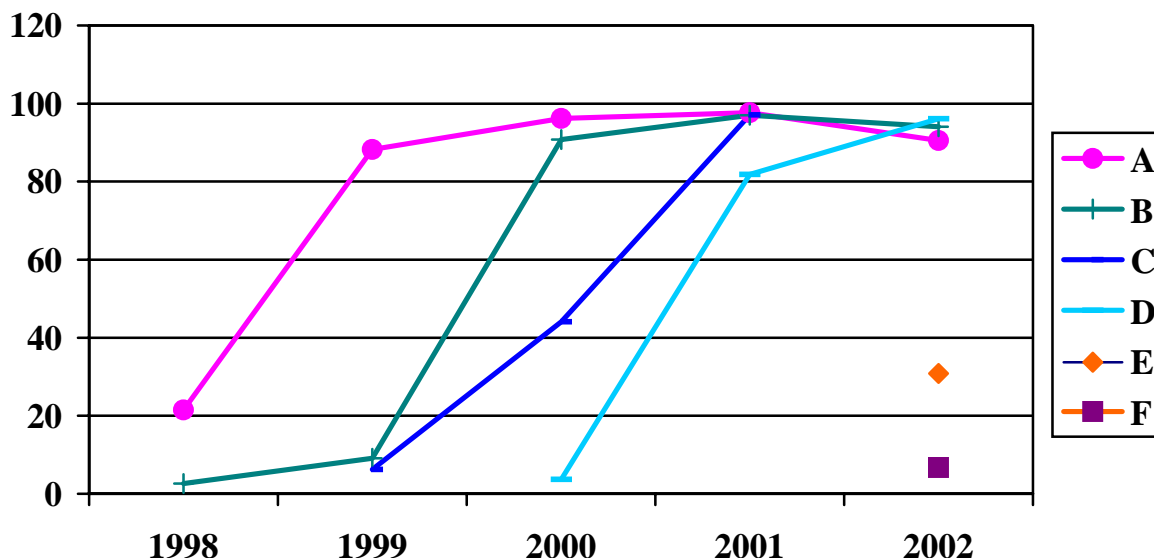
The Biological Control Program, in connection with partnering agencies is currently in the middle of a biological control project on squarrose knapweed. Program staff are actively distributing biological control insects throughout infested areas and evaluating their impact. Early results indicate a highly successful project. A combination of biological control insects appears to have caused a visible and quantifiable impact on this invasive "A" rated weed. The insects are spreading and rapidly increasing in number with an associated near halt in seed production and an increase in the number of dying plants.

Squarrose knapweed is related to yellow starthistle, diffuse knapweed and spotted knapweed. The largest infestations in the United States occur in Utah, and are estimated at over 120,000 acres. California has the second largest acreage, with much smaller amounts in Oregon and Washington. In California, squarrose knapweed occurs along roadsides, in natural areas, and in rangeland, where it can develop into nearly monotypic stands. The California Department of Food and Agriculture and other agencies have a long-standing management program utilizing chemical and physical methods, with the intention of plant reduction, and a goal of eradication. The Biological Control Program initiated biological control efforts in Siskiyou County in 1996, and near the county borders of Lassen, Modoc, and Shasta in 1998. Over a period of several years, five species of insects collected in Oregon were intentionally released as biological controls of squarrose knapweed. Additionally, at least one other insect species has established as a result of natural immigration from other knapweeds. The Siskiyou site was subsequently treated by the Agriculture Commissioner's office as part of an aggressive weed eradication program so biological control was discontinued. We began focusing on the second site and noted a dramatic and rapid buildup of the released biological control insects.

Samples were collected at the end of each summer (beginning in 1998) to assess the percentage of squarrose knapweed seedheads that were attacked by biological control insects. Most sites started with a small percentage (two to six percent) of the seedheads being attacked by the gallfly *Urophora quadrifasciata*. This insect seems to have moved unaided from other knapweed species, probably in Oregon. It has over several years been released and distributed in many states as a biological control of diffuse and spotted knapweed. It is a strong flier so it self-distributes. The insect seems to have spread to and established at a low level over a broad area of Northern California, wherever knapweeds are present. At this low level of attack, its impact is minimal.

Two seedhead feeding weevil species, *Larinus minutus* and *Bangasternus fausti*, have been released by the Biological Control Program and seem to have established rapidly. Results are shown in (Figure 1). The most significant result is the speed of population buildup. Essentially, the seedhead weevils increase rapidly, attacking at least 90 percent of the seedheads in a local area within two years of arrival at the site, either by release or natural movement. Monitoring is being conducted at a few additional sites but laboratory analysis of the samples is not yet complete. Since Sites A through D are similar in features and relatively close together, at additional sites. Sites E through F were established several miles away. They will be monitored to confirm the early data and interpretation.

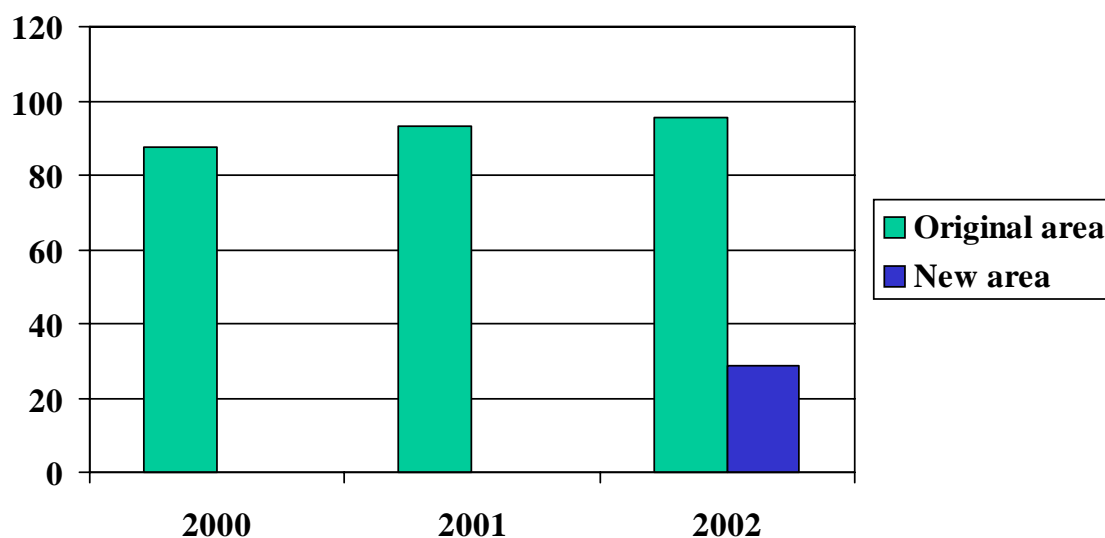
Figure 1: Percentage of Infested Squarrose Knapweed Seedheads at Monitored Sites



Site A received a large number (2000) of insects in 1998
 Site B received a smaller number (200) of insects in 1998
 Site C received a moderate number of insects (400) in 1999
 Site D is 0.5 mile from sites A and B and received no releases
 Site E received a moderate number of insects (500) in 2002
 Site F is 0.2 miles from site E and received no releases

In addition to their rapid population buildup, the seedhead weevils have a dramatic impact on the plant itself. Infested seedheads produce almost no viable seed. Less than one percent of the attacked seedheads produce a single seed. Two methods: (bagged and unbagged seedheads) are being used to monitor the impact of the seedhead insects. The results are consistent with both methods. The total seed destruction is estimated to be 90 percent in the original release area based on measured destruction in monitored heads and the sitewide percentage of attacked seedheads (Figure 2). Seed destruction at the new 2002 release Site E was estimated at 24 percent directly around the insect release area. Based on previous results, this should increase greatly next year.

Figure 2: Percentage of Seed Destroyed by Biological Control Insects



Two root-feeding insects have been released on squarrose knapweed in Northern California. The root-feeding weevil, *Cyphocleonus achates* has yet to establish, while the beetle, *Sphenoptera jugoslavica*, established easily and rapidly. Within four years of release, the root beetle attacked over 80 percent of the plants in the release site. Recently, multiple beetle larvae have been observed within the roots of many of the squarrose knapweeds. Knapweed plants appear to be declining in vigor as a result of the attack. Most of the plants attacked by root-feeding insects now have dead stems and some plants seem to have died as a result of this attack.

Evaluations have been initiated to measure the impact of the biological controls on plant density. During the past two years, dramatic reductions in total knapweed plants per square meter have been measured in two locations within the original 1998 release area (Figure 3).

Figure 3: Squarrose knapweed plant density at two locations within the original (1998) Biological control release area.

